Site: Apples Overall Confidence Rating: High

Background: A total of 641,000 acres are planted in apples in the United states. Organophosphate pesticides (OP) represent 68% of all pesticide usage on this crop with an average of 2.82 applications per year. Analysis of OP usage was conducted for the following five major apple regions: New England (CT, MA, ME, RI, NH, NJ, NY, VT), North Central (MI and OH), Appalachian-Southern (DE, GA, MD, NC, PA, SC, TN, VA, WV), Western (AZ and CA), and Pacific North. (OR and WA). Insecticide use patterns and key pests vary both between and within regions. In the absence of effective controls, key pests can destroy 50-90% of the crop. Due to low damage threshold levels in apples, biological control is limited to indirect pests (non-fruit feeding) with little contribution against direct pests.

Organophosphate	% Tr	eated	# Appl	ications	Rate (lb /	AI/A)	PHI (days)	
Pesticides	Max ²³	Avg ²³	Max ²¹	Avg ²⁻¹¹	Max ²¹	Avg ²⁻¹¹	Min ²¹	Avg
azinphos-methyl	64.7	61.4	4	2.1	3.1	0.8	7	
chlorpyrifos	53	44	NS	1.6	4	1.4	30	
diazinon	6	3	NS	1.6	5	1.2	21	
dimethoate	14.9	7.4	NS	1.3	2.0	0.8	28	
malathion	15	10	NS	1.1	2.3	0.8	21	
methyl parathion	25	18	NS	1.0	2	2.0	21	
phosmet	34	22	NS	2.9	4	1.1	7	

Confidence Rating: H= high confidence = data from several confirming sources; confirmed by personal experience

M = medium confidence = data from only a few sources; may be some conflicting or unconfirmed info.

L = low confidence = data from only one unconfirmed source

Organophosphate Target Pests for Apple in New England Region (Primary pests controlled by the OP's) ^{6,9,17,18}								
Major	Bug (Tarnished Plant), Aphids (Rosy Apple, Apple, and Spirea), Apple Maggot, Plum Curculio							
Moderate	Leafroller (Obliquebanded and Redbanded))							
Minor	Fruitworm (Green and Sparganothis), Sawfly (European Apple), Leafhopper (White Apple and Potato), Scale (San Jose), Mite (European Red), Leafminer (Spotted Tentiform)							

Major = 20+% of all OP usage on pest; Moderate = 5-20% of all OP usage on pest; Minor =<5% of all OP usage on pest

Organophosphate Target Pests for Apple in North Central Region (Primary pests controlled by the OP's) ^{7, 10, 16}										
Major	Iajor Codling Moth, Apple Maggot									
Moderate	Aphid (Green Apple and Rosy Apple), Fruitworm (Green), Leafroller (Fruit Tree, Red Banded, Oblique Banded, and Variegated), Scale (San Jose), Plum Curculio,									
Minor	Mites (European Red, Rust, and Two Spotted Spider), Fruit/Bud Moth (Oriental Fruit, Tufted Apple Bud, and Eye-Spotted Bud), Leafminer (), Bug (Tarnished Plant and Stink), Leafhopper (White Apple and Potato), Borer (Dogwood)									

Major = 20+% of all OP usage on pest; Moderate = 5-20% of all OP usage on pest; Minor =<5% of all OP usage on pest

Organophospha	Organophosphate Target Pests for Apple in Appalachian-Southern Region (Primary pests controlled by the OP's) ^{3,4,14,15}									
Major	ajor Aphid (Rosy Apple, Apple, Spirea and Apple Grain), Codling Moth									
Moderate	Leafroller (Red Banded and Oblique Banded), Scale (San Jose), Mites (European Red, Twospotted Spider, and Apple Rust), Bug (Tarnished Plant and Mullein Plant), Leafhopper (White Apple, Rose, and Potato)									
Minor	Fruit/Bud Moth (Tufted Apple Bud and Oriental Fruit), Leafminer (Spotted Tentiform), Plum Curculio, Apple Maggot, Fruitworm (Green)									

Major = 20+% of all OP usage on pest; Moderate = 5-20% of all OP usage on pest; Minor =<5% of all OP usage on pest

Organophosphate Target Pests for Apple in Western Region (Primary pests controlled by the OP's) ^{8, 19, 20}								
Major	Major Aphid (Rosy Apple, Green Apple, and Green Peach), Codling Moth							
Moderate	Scale (San Jose, Italian Pear, and Grape Mealybug)							
Minor	Mites (European Red, Apple Rust, Pacific Spider, and McDaniel Spider), Borer (Pacific Flatheaded)							

Major = 20+% of all OP usage on pest; Moderate = 5-20% of all OP usage on pest; Minor =<5% of all OP usage on pest

Organophosph	Organophosphate Target Pests for Apple in Pacific North Region (Primary pests controlled by the OP's) ^{2, 11, 12, 13}									
Major	Leafrollers (Pandemis, Oblique Banded, Fruittree, and European), Codling Moth									
Moderate	Scale (San Jose and Oystershell), Fruitworm (Green, Speckled Green, and Pyamidal), Apple Maggot, Aphid (Green Apple, Rosy Apple, and Apple Grain), Mites (European Red, Apple Rust, Twospotted Spider, and McDaniel Spider)									
Minor										

Major = 20+% of all OP usage on pest; Moderate = 5-20% of all OP usage on pest; Minor =<5% of all OP usage on pest

Sources:

- 1. Proprietary EPA market share information.
- 2. U.S. Apple QUA+ Washington. 1997.
- 3. U.S. Apple QUA+ Virginia, West Virginia. 1997.
- 4. U.S. Apple QUA+ Georgia, North Carolina, South Carolina and Tennessee. 1997.
- 5. U.S. Apple QUA+ Pennsylvania. 1997.
- 6. U.S. Apple QUA+ New England. 1997.
- 7. U.S. Apple QUA+ Michigan. 1997.
- 8. U.S. Apple QUA+ California. 1997.
- 9. QUA+ New England Fruit Consultants.
- 10. QUA+ Michigan Apple Commission. 1997
- 11. QUA+ Northwest Horticultural Council. 1997.
- 12. Orchard Pest Management; A Resource Book for the Pacific Northwest.1993. Good Fruit Grower, Yakima, WA.
- 13. Pacific Northwest 1998 Insect Control Handbook. 1998. Oregon State University.
- 14. 1997 Spray Bulletin for Commercial Tree Fruit Growers. Virginia, West Virginia and Maryland Cooperative Extension.
- 15. Pennsylvania Tree Fruit Production Guide. 1996-1997. College of Agricultural Science, Penn State University.
- 16. 1997 Fruit Spraying Calendar for Commercial Fruit Growers. 1997. Bulletin E-154. Michigan State University Extension.
- 17. Pest Management Recommendations for Commercial Tree Fruit Production. 1997. Cornell University.
- 18. 1996-1997 New England Apple Pest Management Guide. Cooperative Extension (Universities. of Connecticut, New Hampshire, Maine, Rhode Island, Massachusetts and Vermont)
- 19. Apple Pest Management Guidelines. 1996. UCPMG Publication 12. IPM Education and Publications, Univ.-CA, Davis.
- 20. Integrated Pest Management for Apples and Pears. 1991. Publication 3340. University of California.
- 21. Label Use Information System (LUIS) Version 5.0, EPA.
- 22. The All-Crop, Quick Reference Insect Control Guide (1997), Meister Publishing Company
- 23. EPA Crop Profile QUA.

Date: 01/28/99

Region: Pacific North

Pest ^{2-6, 9}	Organophosphate ^{1-6, 9}	Effiçacy	Mkt ¹	Class	Alt. Pesticide List ^{1-6, 9}	Efficacy ⁶	Mkt ¹	Constraints of Alternatives ^{2,3,9}
Timing: Pre-Bloo	om							
Leafrollers	azinphos-methyl			С	methomyl			Bacillus thuringiensis use requires
(Pandemis and Obliquebanded)	chlorpyifos	O - ©	High	P	permethrin			mutiple applications and may require multipe BT strains to remain
(Major)	dimethoate			P	pyrethrins			effectivie.
, 3 /	phosmet			СН	endosulfan	•	Lo	Mating disruption of leafrollers using pheromones is untested
				IGR	azadirachtin			commercially
				В	Bacillus thuringiensis	⊙ - ⊚	Lo	
				0	pheromone			
Scale	azinphos-methyl			О	petroleum oil	©	Mod	Oil use alone (without an additional
(San Jose) (Moderate)	chlorpyrifos	0	High					OP) could be effective but could lead to increased plant injury during the
	diazinon							dormant stage. Oil can not be used in the summer at sufficiently high
	methidathion							rates.
	phosmet							

Region: Pacific North

Pest ^{2-6, 9}	Organophosphate ^{1-6, 9}	Effiçacy	Mkt ¹	Clas	Alt. Pesticide List ^{1-6, 9}	Efficacy ⁶	Mkt ¹	Constraints of Alternatives ^{2, 3, 9}
Timing: Pre-Bloo	m							
Mites	chlorpyrifos	• - 😊	High	С	oxamyl			Efficacy of alternatives varies widely
(European red, Apple rust,	dimethoate			Р	pyrethrins			according to targeted species.
McDaniel spider, and Twospotted	malathion			СН	dicofol			Clofentezine should not be applied after tight cluster growth stage.
spider)				СН	endosulfan			
(Minor)				0	calcium polysulfide			
				0	clofentezine	● - ◎		
				0	fenbutatin oxide	O - ©		
				0	formetanate hydrochloride			
				0	hexythiazox	● - ◎		
				О	petroleum oil	O - ©	Mod	
				О	pyridaben			
				О	sulfur			

ADDITIONAL INFORMATION:

Apple production in the Pacific North Region (Oregon and Washington) accounts for 35.6% of total acreage and 54.5% of production for the US. OP usage during the Pre-Bloom period in the Pacific North Region is 92.0% of pesticide usage. San Jose Scale is of continual importance to apple growers in Washington because of the importance of exports, as phytosanitary regulations ban infested fruit from some countries. The threat of mite problems has resulted in Washington State University not recommending pyrethroids as alternatives in apples. Leafrollers have emerged as a key pest under conditions of codling moth pheromone mating disruption. Reduced use of pesticides in this option allows leafrollers to become more prevalent. Bt's are useful for leafroller control if applied a sufficient number of times, however, no alternative to OP's exist should populations inadvertently be allowed to build up in an orchard. Overall, available alternatives to the organophosphates in the Pacific North Region tend to be less effective, more expensive or disruptive to IPM programs.

Pest Importance: Major = 20+% of all OP usage on pest; Moderate = 5-20% of all OP usage on pest; Minor = <5% of all OP usage on pest Efficacy Rating: Excellent = ⊚ Good = ○ Fair = ● --- = Not rated for efficacy in state recs.

Market Share: High = 20+% OP usage on pest; Med = 5-20% of all usage on pest; Lo = <5% of all usage on pest; --- = not available for 1994-96. Insecticides: C = Carbamates; P = Pyrethroids; CH = Chlorinated Hydrocarbons; IGR = Insect Growth Regulators; B = Biological; O = Other pesticide

OP TOLERANCE REASSESSMENT USE/USAGE MATRIX - PEST SUMMARY

(DRAFT)

Page 5

Site: Apples

Region: Pacific North

SOURCES:

- 1. US EPA propietary market share information. 1994-1996.
- 2. QUA+ Oregon. 1997.
- 3. QUA+ Washington 1997.
- 4. Integrated Pest Management for Apples & Pears. 1991.
- 5. Pacific Northwest 1998 Insect Control Handbook. 1998. Oregon State University.
- 5. Orchard Pest Management: A Resource Book for the Pacific Northwest. 1993. Good Fruit Grower, Yakima, Washington.
- 6. 1998 Crop Protection Guide for Tree Fruits in Washington. 1998. Washington State University. Publication EB0419.
- 7. The All-Crop, Quick Reference Insect Control Guide (1997), Meister Publishing Company.
- 8. Label Use Information System (LUIS) Version 5.0, EPA.
- 9. Communications with New England Extension Personnel and Apple Producers.

Date: 01/27/99

Pest Importance: Major = 20+% of all OP usage on pest; Moderate = 5-20% of all OP usage on pest; Minor = <5% of all OP usage on pest Efficacy Rating: Excellent = © Good = O Fair = • --- = Not rated for efficacy in state recs.

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Region: Pacific North

Pest ^{2-6, 9}	Organophosphate ^{1-6, 9}	Effiçacy	Mkt ¹		Class	Alt. Pesticide List ^{1-6, 9}	Effiçacy	Mkt ¹	Constraints of Alternatives ^{2, 3, 9}
Timing: Post-Blo	oom								
Codling Moth	azinphos-methyl	③	High		С	carbaryl	•	Lo	Matring disruption with pheromone is not
(Major)	chlorpyrifos	0	Lo		С	methomyl			a stand alone treatment in most orchards and must be augmented with OP pesticide
	diazinon	•	Lo		P	esfenvalerate		Lo	application.
	dimethoate	•			СН	methoxychlor		Lo	Pyrethroid use is disruptive to biological control of mites.
	malathion		Lo		В	azadirachtin		Lo	control of fines.
	methyl parathion	9	Lo		О	phemone			
	phosmet	O - ©	Lo						
Leafroller (Pandemis and	azinphos-methyl	О	High		С		Pyrethroid use would disrupt established biological control of mites.		
Obliquebanded) (Major)	chlorpyrifos	O - ©	High	High Mod	C	methomyl	● - ◎		Bacillus thuringiensis use may require mutiple BT's to remain effectivie.
(William)	methyl parathion	©	Mod		P	esfenvalerate			Mating disruption with pheromone is
					IGR	azadirachtin	•		untested commercially. Carbaryl use should be delayed at 30 days
					В	Bacillus thuringiensis	O - ©	High	after full bloom to avoid fruit thinning.
					О	imidicloprid		Lo	Imidicloprid should not be applied during bloom or when bees are present in the orchard. This product is more expensive
					О	pheromone			and has the potential for development of resistant populations.

Pest Importance: Major = 20+% of all OP usage on pest; Moderate = 5-20% of all OP usage on pest; Minor = <5% of all OP usage on pest Efficacy Rating: Excellent = ⑤ Good = O Fair = ● ---= Not rated for efficacy in state recs.

Market Share: High = 20+% OP usage on pest; Med = 5-20% of all usage on pest; Lo = <5% of all usage on pest; --- = not available for 1994-96. Insecticides: C = Carbamates; P = Pyrethroids; CH = Chlorinated Hydrocarbons; IGR = Insect Growth Regulators; B = Biological; O = Other pesticide

Region: Pacific North

Pest ^{2-6, 9}	Organophosphate ^{1-6, 9}	Effiçacy	Mkt ¹		Class	Alt. Pesticide List ^{1-6, 9}	Effiçacy	Mkt ¹	Constraints of Alternatives ^{2, 3, 9}
Timing: Post-Bloom									
Aphid (Apple and Green peach)	azinphos-methyl	•	Mod	Mod Lo	С	carbaryl	•	Mod	Some aphid species may be inadequately
	chlorpyrifos		Lo		C	methomyl	0		controlled by alternatives.
(Moderate)	diazinon	• - 🔾			C	oxamyl	•	Lo	Imidicloprid is more expensive and has the potential for development of resistance.
	dimethoate	•	Lo		P	esfenvalerate			Permethrin should not be applied after
	malathion		Lo		P	permethrin			petal fall.
	methyl parathion		Lo	Lo	P	pyrethrins			
	phosmet	•			СН	endosulfan	• - •	Lo	
					IGR	azadirachtin			
					О	imidacloprid	⊚	High	
					О	petroleum oil		Lo	
					O	soap	• - 🔾		
Mites	chlorpyrifos	● - ◎	High		С	oxamyl			
(European red, Apple rust,	dimethoate				P	pyrethrins			
McDaniel spider, and	malathion				СН	dicofol			
Twospotted spider)					СН	endosulfan			
spiaci)					О	clofentezine	● - ◎		
					О	fenbutatin oxide	O - ©		
					О	petroleum oil	O - ©	Mod	
					О	pyridaben			

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Insecticides: C = Carbamates; P = Pyrethroids; CH = Chlorinated Hydrocarbons; IGR = Insect Growth Regulators; B = Biological; O = Other pesticide

Region: Pacific North

ADDITIONAL INFORMATION:

Apple production in the Pacific North Region (Oregon and Washington) accounts for 35.6% of total acreage and 54.5% of production for the US. OP usage during the Post-Bloom period in the Pacific North Region is 73.5% of all pesticide usage.

Codling Moth is the most destructive pest of apples in Washington and Oregon. Apple losses from this insect alone would exceed 50% in one or two years if no insecticides were applied for control. Phermone disruption of mating is only effective where Codling Moth populations are low to moderate and must still be supplemented with insecticide applications.

The threat of mite problems has resulted in Washington State University not recommending pyrethroids as alternatives in apples.

Leafrollers have emerged as a key pest under conditions of codling moth pheromone mating disruption. Reduced use of pesticides in this option allows leafrollers to become more prevalent. Bt's are useful for leafroller control if applied a sufficient number of times, however, no alternative to OP's exist should populations inadvertently be allowed to build up in an orchard.

Overall, available alternatives to the organophosphates in the Pacific North Region tend to be less effective, more expensive or disruptive to IPM programs.

SOURCES:

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- 3. QUA+ Northwest Horticultural Council. 1997.
- 4. Orchard Pest Management; A Resource Book for the Pacific Northwest.1993. Good Fruit Grower, Yakima, WA.
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 $Market\ Share:\ High\ =\ 20+\%\ OP\ usage\ on\ pest;\ Med\ =\ 5-20\%\ of\ all\ usage\ on\ pest;\ Lo\ =\ <5\%\ of\ all\ usage\ on\ pest;\ ---\ =\ not\ available\ for\ 1994-96.$

Insecticides: C = Carbamates; P = Pyrethroids; CH = Chlorinated Hydrocarbons; IGR = Insect Growth Regulators; B = Biological; O = Other pesticide